

# The Bank Capital Channel and Counter-Cyclical Prudential Regulation in a DSGE model

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## Introduction

Large number of studies on the credit channel of monetary policy have allowed us to achieve a better grasp of the mode of propagation of shocks (particularly financial shocks) and the transmission of monetary policy impulses. However, although this theory very relevantly puts the credit fluctuations at the heart of the economic cycle, the role it finally gives banks is passive. In particular, it does not take into account the question of how their balance sheet structure impacts the conditions underlying the funding of banks and hence their corporate loan terms.

Several contributions have developed a complementary branch of the broad credit channel by laying the groundwork for a “bank capital channel” (Blum & Hellwig (1995), Van Der Heuvel (2002a), Chami & Cosimano (2001), Chen (2001)), their aim being to clarify the mechanism by which the procyclicality of bank balance sheets leads to the propagation and amplification of shocks<sup>1</sup>. The premise of this literature is that the amount of banks’ equity capital determines the conditions under which banks may procure funds not covered by deposit insurance (bonds, certificate of deposit, etc.). From this point of view, assuming there is an agency problem between banks and their creditors, the question of bank funding in the bank capital channel theory is raised in the same terms as that of corporate financing in the financial accelerator theory. Typically, the movement of asset prices has an accounting impact on a bank’s capital (admittedly through a direct effect on its equity portfolio, but also through its effect on the credit portfolio). Jointly, credit institutions face an interest rate risk given that their asset structure does not match their liability duration. So, during a favourable

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<sup>1</sup> Cf. Levieuge (2005) for a detailed assessment of the bank capital channel.

play a part in the procyclicality of bank capital (Bikker & Metzmakers (2005)). In accordance with the generally prevailing regulation, allocations to provisions are registered solely after losses are confirmed, notwithstanding the fact that the credit risk exists as from the signature of the contract. In the absence of an immediate recording of credit risks, bank balance sheets show insidious and latent deterioration during economic growth. Consequently, the massive and effective recording of losses during a downturn weighs all the more on banks' capital and hence on their credit supply.

Thus, if the procyclical behaviour of banks is responsible for the transmission and the amplification of financial shocks to real activity, all measures which aim at disconnecting banks' balance sheets from financial cycles (even to a partial extent) deserve scrutiny. In this respect, economists have focused on setting up a dynamic provisioning framework (or *ex ante* provisioning). This measure means that the existence of risk is taken into consideration from the time the loan is granted. The inherent expectation of probable risks has the advantage of spreading out losses and thus restricting the procyclicality of banks' practices. However, this type of measure (and, generally speaking, all prudential measures) has not been examined within an adequate theoretical structure. Moreover, ahead of regulated solutions, through the priority given to a partial equilibrium analysis, previous research setting forth the bank capital channel has not taken into account its macroeconomic implications. Finally, no contributions (except for the attempt made by Meh & Moran (2003)) have considered both the bank capital channel and the financial accelerator mechanisms.

This article aims to provide a response to these three shortcomings. To this end, the reference dynamic stochastic general equilibrium (DSGE) model of Bernanke et al. (1999) (hereafter BGG) has been modified so that the balance sheet structure of financial intermediaries affects credit supply and conditions. Typically, it is presumed that banks must raise funds to finance firms. Since there is an agency problem between households and banks (the solution for which involves costly monitoring), the banks must bear an external financing premium, inversely linked to their level of equity. It follows that the amplification of shocks stands out all the more in that banks finally pass the cost variations of their own funding on to firms. Furthermore, in so far as this theoretical framework takes into account bank provisions, it makes it possible to go ahead with an assessment of the advantages associated with dynamic provisioning in terms of output, inflation and interest rate volatility. Since this type of measure holds within it all the potential appeal of a prudential and preventive step, this exercise involves, generally speaking, the first simulation of the expected effects of a counter-cyclical prudential policy within a DSGE model.

Section 1 lays forth the broad features of the model. The agents, the relations between them, and the modifications to the BGG reference frame-



Furthermore, households offer their labour to wholesalers and consume retail goods. They own the retail enterprises and the banks. They are risk-averse. They finance the banks (which are risk neutral) and mandate them for wholesaler financing. This usually presumes that banks, here in competition, hold an advantage in monitoring firms' projects. But it is also assumed that the loan portfolio of banks are a finite size, which does not allow for a perfect diversification of disturbances and renders their verification necessary. And, as firms' results constitute private information, the same applies to banks' results. Thus, a household must incur costs if it wants to verify the results of a bank. This sets up (via the usual costly state verification framework) an external financing premium for the bank which has a consequent incentive to hold capital<sup>3</sup>. In this sense, unlike Van Den Heuvel (2002a), the holding of bank capital is justified by market-based rather than regulatory based constraints. Finally, it is reasonable to presume that the anticipated bank verification costs are lower than the earnings arising from bank management and control.

In fact, within this framework, banks behave like monitors delegated by households to supervise the firms' investment projects. And households play the role of "monitoring the monitor"<sup>4</sup>. Thus the functioning of the bank sector is made explicit, which allows the influence of capital and bank provisions on macroeconomic equilibrium and fluctuations to be studied.

In addition to this contribution, the modifications to the BGG model are:

- The bankruptcy rate of firms is endogenous.
- The wholesalers bear internal adjustment costs (instead of external costs).
- The Calvo price setting model is replaced by that of Gali & Gertler (1999). Among the retailers who modify their prices, only a fraction comply with its maximisation programme. The others merely update their prices by reference to past inflation. This assumption leads to the definition of a hybrid Phillips curve, more valid empirically than a purely forward-looking Phillips curve.
- Consumers exhibit habit formation. This assumption allows for the persistence of the model, in the sense of better adequacy with stylised facts.
- Calibration is based on the euro area.

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<sup>3</sup> On the contrary, in the BGG model, it is not necessary for banks to hold equity capital since they perfectly diversify the idiosyncratic risks associated with each of the investment projects of a firm (which implies that these risks are not passed on to the ultimate lenders which are the households). This is why banks are finally transparent in the BGG model.

<sup>4</sup> See Krasa & Villamil (1992) for example.

$$B_{t+1}^{B,j} = Q_t K_{t+1}^i - N_{t+1}^{F,j} - W B_{t+1}^j \quad (5)$$

Banks are subject to a disturbance, denoted  $\varepsilon^j$ , which is a random i.i.d. variable with a continuous and once-differentiable c.d.f.  $F_B(\varepsilon)$  over a non-negative support and with  $E(\varepsilon^j) = 1$ . The *ex post* return of bank  $j$  is then given by <sup>6</sup>  $R_{t+1}^B$ .

In compliance with the costly state verification framework à la Townsend (1979), households (creditors) cannot spontaneously observe banks' results. To do so, they need to carry out a costly audit in proportion ( $\mu_B$ ) to the results announced by the borrowers. The monitoring costs borne by a household wishing to verify the results of bank  $j$  (having made a loan to firm  $i$ ) are hence equal to  $\mu_B \varepsilon^j R_{t+1}^B B_{t+1}^{i,j}$ . The existence of this agency problem will, therefore, make external funding costly for banks.

The solution of the agency problem complies with the following rationale. The household determines a threshold  $\bar{\varepsilon}^j$  which is defined such that for all values of shock  $\varepsilon^j$  above this limit, the bank is able to honour its commitments. In this case, the creditor gets back  $\bar{\varepsilon}^j R_{t+1}^B B_{t+1}^{i,j}$  and the bank ( $\varepsilon^j - \bar{\varepsilon}^j$ )  $R_{t+1}^B B_{t+1}^{i,j}$ . Otherwise, it declares bankruptcy; the creditor verifies the declaration and keeps all the remaining funds (minus audit costs), i.e.  $(1 - \mu_B) \varepsilon^j R_{t+1}^B B_{t+1}^{i,j}$ . The loan contract must satisfy the following participation constraint:

$$\begin{aligned} & [1 - F_B(\bar{\varepsilon}^j)] \bar{\varepsilon}^j R_{t+1}^B B_{t+1}^{i,j} + (1 - \mu_B) \int_0^{\bar{\varepsilon}^j} \varepsilon^j R_{t+1}^B B_{t+1}^{i,j} dF_B(\varepsilon) \\ & = R_{t+1} [B_{t+1}^{i,j} - W B_{t+1}^j] \end{aligned} \quad (6)$$

where  $[1 - F_B(\bar{\varepsilon}^j)]$  reflects the bank's success probability. The first term on the left expresses the amount recovered by households if the bank's investments are successful. The second represents what is reimbursed by the bank in the case of failure minus monitoring costs. The sum of the two must correspond to what households would obtain had they chosen risk-free saving with an interest rate <sup>7</sup>  $R$ . It is shown that any increase in the threshold brings about two opposite effects on the creditors' expected gains. While it

<sup>6</sup> Because  $R_{t+1}^B$ , the non-idiosyncratic component of the banks' rate of return to capital, is achieved only at the end of the period, bank  $j$  runs an aggregate risk in addition to the idiosyncratic risk.

<sup>7</sup> Households are neutral to idiosyncratic risks but averse to aggregate risks. It may be presumed that the risk-free rate is established at the beginning of the period whereas  $R^B$  is determined and known solely at the end of the period. Henceforward, based on Equations (6) and (12), if  $R_{t+1}^F$  is lower than the expected value, (i.e. if the non idiosyncratic component of firm  $i$ 's rate of return on investment is lower than expected), the households derive the benefit of a higher return  $R_{t+1}^B$ . Thus, they are hedged against any realisation of aggregate risk. It is to be denoted that the initial assumption leads to a duration mismatch between assets and liabilities in the bank's balance sheet (see Sunirand (2003) for a discussion of this point). However, it remains nonetheless artificial since financial contracts have only one period maturity. It is justifiable essentially to ensure the consistency of risk sharing.



At this stage, the state equation determining the evolution of the net wealth of banks (at the end of period  $t$ ) may be formulated as:

$$N_{t+1}^B = \gamma_B V_t^B + T_t^B = [\gamma_B (1 - \tau) + \tau] V_t^B \quad (10)$$

Given  $N^B$ ,  $WB$ ,  $N^F$ ,  $Q$ ,  $R$  and the distribution of disturbances, the maximisation of Equation (8) subject to constraint (6) allows the amount of capital borrowed by banks from households and the optimal threshold  $\bar{\varepsilon}^j$  to be determined. According to the first order conditions of this programme, the solution of the agency problem gives rise to an external finance premium ( $S^B$ ) borne by the banks, i.e.:

$$S_t^B \equiv E_t \left( \frac{R_{t+1}^B}{R_{t+1}} \right) = \psi_B \left( \frac{Q_t K_{t+1} - N_{t+1}^F}{WB_{t+1}} \right) \quad \text{with } \psi_B(1) = 1 \quad \text{and } \psi_B'(\cdot) > 0 \quad (11)$$

This premium, defined as the difference between the required rate and the risk free rate, depends positively on the debt-equity ratio of the bank ( $B_{t+1}^B / WB_{t+1}$ ). Bank equity capital evidently plays a determining part in the cost of external finance; the greater its net wealth, the greater the extent to which a bank is in a position to reduce the conflict of interest opposing it to its creditor. This result allows for the immediate expectation of the effect of credit losses; an increase in corporate bankruptcy brings about an increase in provisions which erode bank capital. Consequently, the banks concerned must bear a higher external finance premium (counter-cyclical) which they then pass on to corporate credit conditions. Thus, a recessionary shock, whose consequences would be to cut down a bank's economic capital, implies an increase in external finance costs and a drop in investment. As the slowdown in the economy would in turn reduce the banks' balance sheet, the impact of the initial shock is self-sustained and amplified.

Relation (11) further sets up the financing supply curve for banks; households require the return of the loan granted to banks to be equal to the real risk-free interest rate to which is added an endogenous external finance premium. The following section aims to determine the optimal debt contract between banks and firms, which will allow  $B_{t+1}$  to be explicated.

### 2.1.2 Financial relations between banks and firms

Wholesalers are also subject to an aggregate risk and to a random and idiosyncratic disturbance denoted  $\omega^i$ , which is i.i.d. across time and firms, with  $E(\omega) = 1$ .  $F_F(\omega)$  is its continuous and once differentiable c.d.f. over a non-negative support. If the *ex post* aggregate return to capital is denoted  $R^F$ , the *ex post* gross return on capital for firm <sup>10</sup>  $i$  is  $\omega^i R_{t+1}^F$ . At the begin-

<sup>10</sup> Like  $\varepsilon^j$ ,  $\omega^i$  occurs at the end of period  $t$ , which implies that its value is contingent upon the *ex post* realisation of  $R_{t+1}^F$ .

This relation may be viewed as the supply curve for wholesaler investment financing. Banks effectively require that the return on physical capital matches the opportunity cost (stemming from their own fund raising), to which is added an external finance premium that is a function of the debt level and the net wealth of firms. It also conveys the opportunity cost of banking funds which firms are forced into internalising. When banks have to face an increase in their financing costs, they reduce credit supply and/or tighten credit conditions to firms. In doing so, they affect the accumulation of firms' profits ( $V_t^F$ ), defined following Equation (13) by:

$$V_t^F = R_t^F Q_{t-1} K_t - \left( R_t^B + \frac{\mu_F \int_0^{\omega^j} \omega R_t^F Q_{t-1} K_t dF_K(\omega)}{Q_{t-1} K_t - N_t^F} \right) (Q_{t-1} K_t - N_t^F) \quad (16)$$

Wholesalers' profits depend negatively on  $R^B$ . Consequently, the health of the banking sector also impacts on the net wealth  $N_{t+1}^F$  of firms, arising both from accumulated profits and wages received by firms not having gone bankrupt:

$$N_{t+1}^F = \gamma_F(.) V_t^F + W_t^F \quad (17)$$

Thus not only do banks pass on the increase in their financing costs to their credit conditions for firms but, in addition, the latter have to bear an external finance premium which is all the higher because these tighter credit conditions erode their net wealth, as is implied by the financial accelerator mechanism.

Finally, firms which default, in proportion  $[1 - \gamma_F(.)]$ , consume in final goods all the wealth they have accumulated during their existence:

$$C_t^F = [1 - \gamma_F(.)] V_t^F \quad (18)$$

## 2.2 General equilibrium

Once the two external financing premiums have been determined, these relations have to be fitted into a dynamic stochastic general equilibrium model to thus endogenise the risk-free rate, the returns on bank and on physical capital, which until now were given, to solve the partial equilibria.

### 2.2.1 Wholesalers and producers of physical capital

Wholesalers and producers of physical capital intervene in a competitive market. Wholesalers purchase a stock of capital  $K$  from physical-capital producers, which they combine with labour  $L$  to produce wholesale goods denoted  $Y$  with this Cobb-Douglas constant returns to scale technology:

$$F(\varepsilon_t^a, K_t, L_t) = Y_t = \varepsilon_t^a K_t^\alpha L_t^{1-\alpha} \quad (19)$$

The FOC relative to  $K_{t+1}$  may then be written as follows:

$$E_t(R_{t+1}^F) = E_t \left[ \frac{\rho_{t+1} \frac{\alpha Y_{t+1}}{K_{t+1}} - \frac{\Theta}{2} \left[ \delta^2 - \left( \frac{I_{t+1}}{K_{t+1}} \right)^2 \right] + (1 - \delta) Q_{t+1}}{Q_t} \right] \quad (23)$$

This relation defines the expected return of one unit of physical capital: an additional unit of capital purchased in  $t$  at price  $Q_t$  allows for the production of  $\alpha \frac{Y_{t+1}}{K_{t+1}} \rho_t$  additional units of wholesale goods, then sold at a unit price in  $t+1$ . But it may also be resold once depreciated  $(1 - \delta)$  at price  $Q_{t+1}$ . The Relation (23) may also be viewed as a wholesalers' demand curve for capital. Finally, the FOC relative to  $I_t$  defines the Tobin's  $Q$  ratio:

$$Q_t = 1 + \frac{\partial A(\cdot)}{\partial I_t} \quad (24)$$

## 2.2.2 Retail sector

A continuum of retailers of measure one operate in a monopolistic competitive market. Each retailer purchases units of wholesale goods at price  $1/X_t$ , which they differentiate at no resource cost. Then they sell them to households and capital producers, at a unit price  $P_t$ . Thus, the real marginal cost of the final goods corresponds only to the purchase price of the "raw material", i.e.  $\rho_t \equiv 1/X_t$ .

Denoting the final good sold by retailer  $z$  (which is equivalent to the quantity of wholesale purchased goods) as  $Y_t(z)$ , the CES composite of individual retail goods and the corresponding price index are formulated as:

$$Y_t = \left[ \int_0^1 Y_t(z)^{\frac{\epsilon-1}{\epsilon}} dz \right]^{\frac{\epsilon}{\epsilon-1}} \quad \text{and} \quad P_t = \left[ \int_0^1 P_t(z)^{1-\epsilon} dz \right]^{\frac{1}{1-\epsilon}} \quad (25)$$

respectively, where  $\epsilon$  represents the elasticity of substitution between the differentiated goods. Consequently each retailer deals with an isoelastic demand curve such that  $Y_t(z) = (P_t(z)/P_t)^{-\epsilon} Y_t$ .

The retailer sector allows for the introduction of a nominal rigidity without complicating the solving of the model. Following Gali & Gertler (1999), we assume that the opportunity to update their prices each period is open to only a certain proportion  $(1 - \phi)$  of retailers (the remaining proportion  $\phi$  leaving them unchanged). Moreover, among these retail enterprises, only a fraction  $(1 - \phi)$  review their prices optimally (these being the enterprises described as "forward-looking"), the remaining fraction  $\phi$  choosing a backward-looking pricing rule. This device allows a hybrid Phillips curve to be



mation mechanism ( $C_{t-1}^h$ ) is integrated into this function. Its influence on current utility is greater or lesser depending on the value of the parameter  $h \in [0, 1]$ . This device allows for increasing sluggishness of consumption and implies a gradual hump-shaped pattern consistent with empirical evidence (Fuhrer (2000), Boldrin, Christiano & Fischer (2000)).

In addition to their returns on capital invested in banks and their wages ( $W_t$ ), households receive dividends (denoted  $\Pi_t$ ) from their ownership of retail enterprises. Further, households consume part of the wealth of failed banks. This consumption is denoted  $C_t^B$  and corresponds to what remains once they have invested part of the capital of such failed banks in new financial intermediaries, i.e.  $(1 - \tau)(1 - \gamma_B)V_t^B$ , which we denote as  $\Pi_t^B$ . Finally, taking into account the levying of lump-sum government taxes, the intertemporal budget constraint of the representative household is written as:

$$C_t + \frac{B_{t+1}^B}{(1 + i_t^B)P_t} + C_t^B \leq W_t H_t + \frac{B_t^B}{P_t} - T_t + \Pi_t + \Pi_t^B \quad (30)$$

where  $i_t^B$  represents the return on loans granted to banks (for an amount  $B_t^B$ ).

The maximisation of Equation (29) under Constraint (30) leads to the following first order conditions with respect to  $C_t$ ,  $B_{t+1}^B$  et  $H_t$  :

$$\lambda_t = \left( \frac{C_t}{C_{t-1}^h} \right)^{\frac{\sigma_c - 1}{\sigma_c}} \frac{1}{C_t} - \beta h E_t \left[ \left( \frac{C_{t+1}}{C_t^h} \right)^{\frac{\sigma_c - 1}{\sigma_c}} \frac{1}{C_t} \right] \quad (31)$$

$$0 = \lambda_t - (1 + i_t^B) \beta E_t \lambda_{t+1} \frac{P_t}{P_{t+1}} \quad (32)$$

$$H_t = (\lambda_t W_t)^{\sigma_h} \quad (33)$$

According to the habit-formation assumption, the Relation (31) implies that current consumption depends not only on expected but also on past consumption. The Euler's relation is obtained by combination with Equation (32). Finally, the first order condition (33) defines labour supply.

## 2.2.4 Government spending, monetary policy and the resource constraint

Government expenditure ( $G$ ) is financed by lump-sum taxes. The equality  $G_t = T_t$  defines its budget constraint. Public spending evolves according to:

$$\ln(G_t) = (1 - \rho_g) \ln(\bar{G}) + \rho_g \ln(G_{t-1}) + \varepsilon_t^g \quad (34)$$

where  $\varepsilon_t^g$  is an exogenous disturbance to government spending and  $\rho_g < 1$ .



the net wealth of the agents (banks and firms) is artificially inflated. Consequently, the specious improvement of their balance sheets allows them to face more favourable credit conditions.

### 3 Calibration

Table 2 in the appendix exhibits the calibration for the parameters and the variables at their steady state. Some are well-known. This is true of  $\delta$ , the depreciation rate of capital (fixed at 0.025), the discount rate fixed at 0.99 (which implies  $R^B = 1.0101$ ) and the capital share (0.35) in the added value. The share of income accruing to entrepreneurial labour is negligible ( $\Omega = 0.99$ ). As usual, the capital adjustment cost parameter is relatively high ( $\Theta = 10$ ). With regard to consumption, the intertemporal elasticity of substitution ( $\sigma_c$ ) and the elasticity of labour disutility ( $\sigma_h$ ) are conventionally respectively fixed at 0.75 and 0.32. In addition, the habit-formation parameter ( $h$ ) is fixed at 0.6, a value within to the interval [0.57-0.96] considered by for instance Smets & Wouters (2002) and Sahuc (2002).

Concerning the Phillips Curve, it is assumed that only a quarter of firms modify their prices each period ( $\phi = 0.75$ ) and only half of these reset their prices optimally ( $\varphi = 0.5$ ). Given  $\beta$ , these assumptions imply an inertial coefficient equal to 0.40 and a coefficient for the forward term close to 0.60. This is a suitable calibration for the euro area (See Galí & Aí. (2001), Bardsen & Aí. (2002)). The coefficient associated with the real marginal costs is 0.026.

A statistical examination of the data provided by the ECB in its Monthly Bulletin suggests that the average banks' capital ratio (i.e. the equilibrium value of  $\overline{WB}/\overline{B}$ ) is equal to 0.15. Next, while there is no aggregated assessment for the default rate on the European scale, rare are the banks that file for bankruptcy in Europe (See Ehrmann & Aí. (2001), Gropp & Aí. (2002)). The survival rate of banks ( $\gamma_B$ ) must therefore be high (0.99). And to be completely consistent, it must be even higher than the survival rate (at the steady state) of firms ( $\bar{\gamma}_F$ ). Finally, it is assumed that households reinvest half the wealth of outgoing banks in the capital of incoming banks and consume the other half ( $\tau = 0.5$ ).

Given that banks pass on their own premium to that of firms, the elasticity of the bank and firm premiums to their respective balance sheet structures does not need to be inordinately high to provoke an amplification of shocks. As will be shown by dynamic simulations, the elasticities  $\psi_B^E$  and  $\psi_F^E$ , fixed at 0.015 and 0.02 respectively, suffice to amplify the shocks, compared with a standard DNK model. In the absence of accurate knowledge about the sensitivity of the firms' survival rates to economic activity ( $f^E$ ), the conclusions arising from the simulations were evaluated on the basis of

First of all, in the model without financial frictions, as expected, the increased interest rate brings about decreased investment (because of the cost-of-capital increase) and consumption. The resulting decline in output in turn leads to a decrease in inflation.

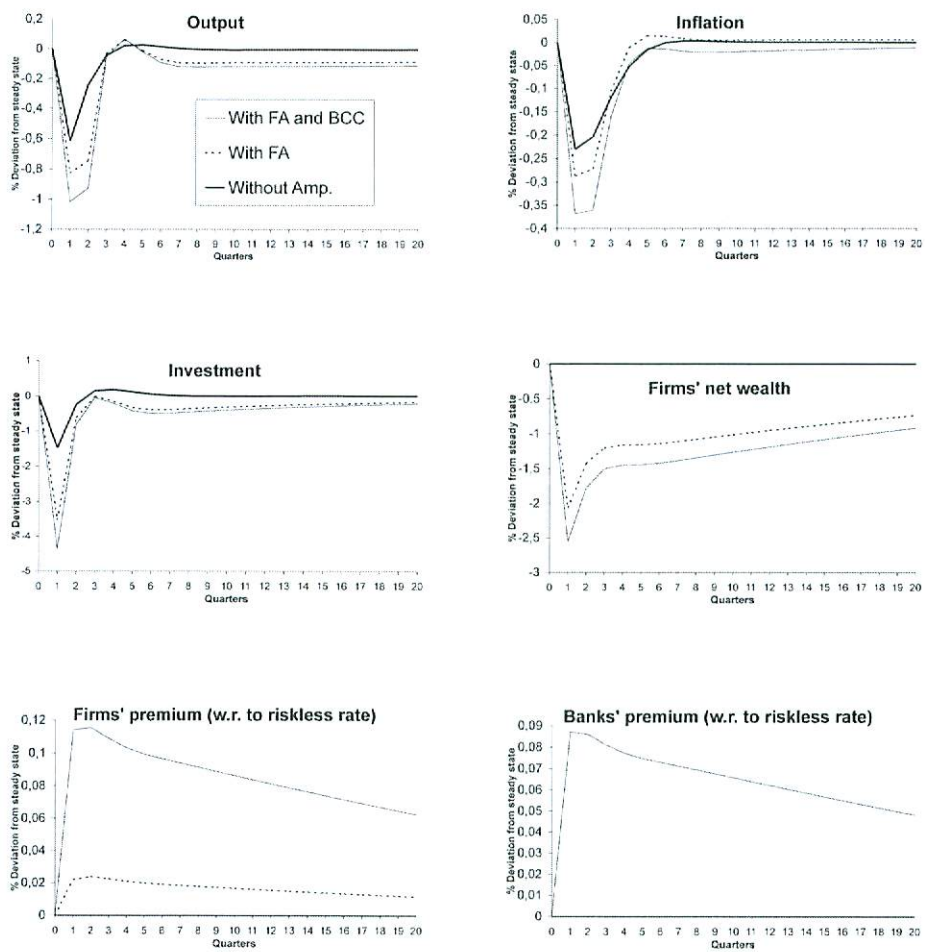


Figure 1: Response to a monetary policy shock: with/without amplifying effects

Two channels then explain the decrease in investment in the model integrating a financial accelerator mechanism. On the one hand, the interest rate rise is transmitted through the usual cost-of-capital channel. On the other hand, the monetary shock erodes the net wealth of the wholesalers, which worsens agency conflicts. Consequently, the increase in the interest rate is clearly reflected in Figure 1 by the increase in the external finance premium borne

put trade-off. In this example, as priority is given to the stabilisation of inflation ( $\beta_\pi > \beta_y$ ), the interest rate increase intended to fight inflation leads to an output sacrifice (See Figure 2).

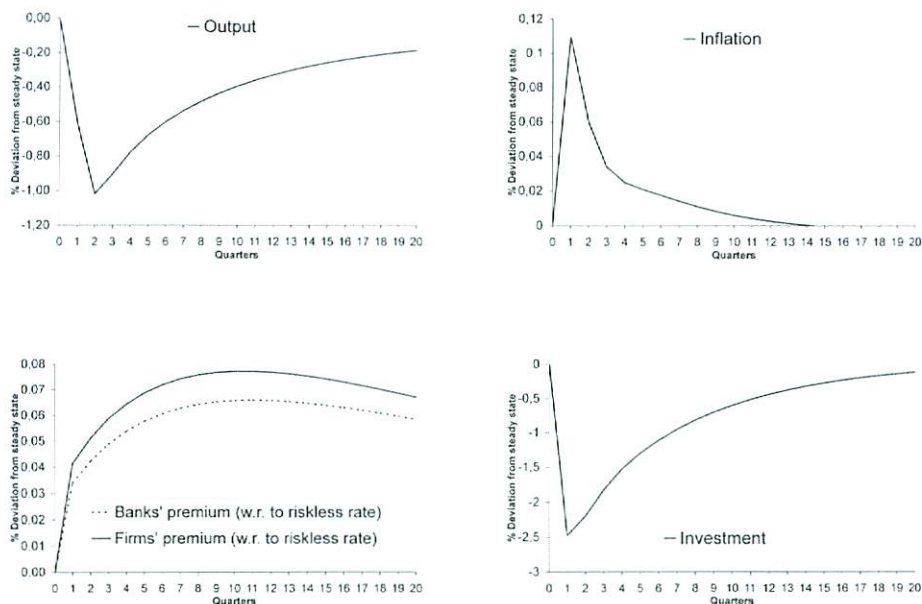


Figure 2: *Technology shock*

As in the case of a monetary policy shock, the riskless rate increase and the external finance premium decrease (due to the decline in the economic capital of banks) both contribute to tightening the banks' financing conditions. In order to compensate for this rise in the opportunity cost of their capital stock holding, banks charge firms a higher loan rate. This tightening of credit conditions hits all the harder in that the firms' net wealth, moreover, deteriorates. Finally, the decline in investment adds to the decrease in consumption to bring production down.

#### 4.3 Effects of an asset-price bubble

We also run simulations to evaluate the effects of an asset-price bubble whose occurrence, expansion and burst are exogenous, in line with the method used by Bernanke & Gertler (1999). Given the values of  $a$  and  $p_F$ , the bubble grows (for one year) and doubles every quarter. The crash is not expected by the agents. Figure 3 illustrates the response of the model to this scenario<sup>13</sup>.



In addition, the consumption of households is partly stimulated by the increased wealth of the outgoing banks. Subsequently, as was demonstrated by the hi-tech stock markets at the beginning of the 2000's, the illusory increase in the net wealth of firms – synonymous with the artificial growth of their returns – increases their cash flow and, above all, leads to banks offering them more favourable credit conditions. Consequently, since banks' equity capital increases with the return of their assets, the return to banks is itself enhanced by the bubble. The decrease in the credit charge is, therefore, all the greater in that, encouraged by apparently higher economic capital, banks also benefit from a decrease in their own financing costs. In short, in so far as creditors (banks and households) are sensitive to the market capital value of their debtors, they are deceived by the asset-price bubble.

The bubble also affects the cost of physical capital through the Tobin's Q ratio channel. Like Bernanke & Gertler (1999), we assume that firms make investments based on fundamental considerations rather than on valuations of capital including the bubble (i.e. according to  $Q_t$  rather than  $Z_t$ ). This choice is justifiable in the light of the studies carried out by Andersen & Subbaraman (1996), Tease (1993) and Chirinko & Schaller (1996). Entrepreneurial projects are insensitive to bubbles, and so are never driven by speculative purposes. All the same, as shown by the last box of Figure 3, the bubble manages to bring about an increase in the fundamental value of enterprises. So enterprises benefit from the decreased credit cost to invest more. The joint increase of investment and consumption stimulates activity and generates inflationary pressures. This mechanism is self-sustaining until the bubble bursts. Immediately afterwards, the collapse in asset prices drastically cuts the net wealth of banks and firms thus bringing about a drop in investment and consumption. The economy then goes through a period of recession before returning to its steady state.

## 5 Impact of the financial context

Theoretical and empirical studies of the bank capital channel show that the impact of shocks depends on the structure of banks' balance sheets (Kishan & Opiela (2000), Van Der Heuvel (2002*b*), Altunbas et al. (2002)). Low-capitalised banks would be more sensitive to shocks than other banks: while healthy banks can adjust their dividend policy to dampen the effects of a crash, weak banks cannot count on this leeway. By extension, the lesser the degree of capitalisation of the banking sector as a whole, the greater the possibility of the strong amplification of cycles. The financial context is, therefore, essential in order to explain the greater or lesser impact of shocks.

The model allows this essential characteristic to be reproduced. The financial context may be reflected by the value, at the steady state, of the

less sensitive to the well-being of enterprises than to the health of banks; when  $\bar{N}^F/\bar{K}$  passes from 0.4 to 0.2, banks' and firms' premiums rise by around 55% and 40% respectively.

## 5.2 Volatility of output and inflation depending on the financial context

To what extent do macroeconomic variables (particularly inflation and output) show the same sensitivity to the financial context? Since the question involves measuring their variance according to the context, two configurations are studied together with the baseline configuration ( $\bar{WB}/\bar{B} = 0.1538$ ): the first assumes that the banks' financial structure is healthy ( $\bar{WB}/\bar{B} = 0.225$ ), whereas the second assumes that it is weak ( $\bar{WB}/\bar{B} = 0.075$ ), given  $\bar{N}^F/\bar{K} = 0.4$ .

The first column of Figure 5 shows the variance of output ( $Var(y)$ ) and inflation ( $Var(p)$ ) depending on the banks' equity to assets ratio. Whatever the shock (technology shock or bubble), the volatility of both variables is effectively greater in a context of weakness. Moreover, inflation is observed to be the most sensitive variable; when the bank sector moves from a healthy framework to a weak one, its variance is multiplied by 9 for a technology shock and by 5 for an asset-price bubble. With regard to output variance, the respective increases reach 55% and 40%.

Finally, it would appear that the differences between a healthy framework (corresponding to the baseline configuration) and a weak one are relatively tenuous, which suggests that the sensitivity of the model to the ratio  $\bar{WB}/\bar{B}$  is not linear within the interval considered. This result is in line with previous studies on the bank capital channel; a negative shock has no significant effect as long as banks are well-capitalised (banks can easily adjust their balance sheets to lessen the effects of a shock), whereas it results in more severe tightening of the financial constraints brought to bear on banks which are initially low-capitalised.

To complete this analysis, the second column shows the volatility of output and inflation according to the global context (considering both the banks' and the firms' balance sheet structures): in addition to the baseline configuration, the model successively reflects a global context of healthy balance sheets ( $\bar{WB}/\bar{B} = 0.225$  and  $\bar{N}^F/\bar{K} = 0.6$ ) and a context that is globally weak ( $\bar{WB}/\bar{B} = 0.075$  and  $\bar{N}^F/\bar{K} = 0.2$ ). Again, it clearly appears that the weaker the structure of the balance sheets of banks and firms, the greater the extent to which the macroeconomic variables are sensitive to shocks. In the extreme, when the two sectors are simultaneously low-capitalised, the variance of inflation is multiplied by 35 for a produc-



## 6 The effects of dynamic provisioning

Dynamic provisioning is based on the idea that the net wealth of banks is closely linked to their practices in terms of allocations to provisions. Indeed, apparently sound solvency ratios may show a sharp turnaround when the risk inherent to a loan portfolio has been incorrectly assessed. In this sense, latent risks are not duly recognised under a static provisioning system such as that considered until now in the model (where allocations to provisions at the end of a period correspond to the amount of credit granted, weighted by the bankruptcy rate actually observed). On the other hand, dynamic provisioning consists of recognising risk right from the start and funding reserves immediately in terms of making provision for future depreciation<sup>14</sup>. During an economic expansion, the accumulation of provisions (in the wake of credit expansion) allows the increase in expected losses usually recorded during an economic slowdown to be offset. This is what is shown in Fernandez de Lis & Al. (2000)'s and Matherat (2003)'s simulations. As a result, this regulation is intended to smooth banking profits and capital, to strengthen the solvency of banks, and is likely to tone down the effects of the bank capital channel<sup>15</sup>. So much so that the fluctuations induced by the banks' behaviour should be attenuated.

Along these lines, it is henceforward assumed that banks comply with this dynamic provisioning principle. At the end of period  $t$ , banks make provisions up to the extent of the loans they have granted (for  $t + 1$ ) on the basis of the expected bankruptcy rate<sup>16</sup>. Relation (4) of the model is, therefore, replaced by:

$$M_{t+1} = E_t \left\{ [1 - \gamma_f(\cdot)] R_{t+1}^F \right\} B_{t+1} = E_t \left\{ \left[ 1 - f \left( \frac{Y_{t+1}}{Q_t K_{t+1}} \right) \right] R_{t+1}^F \right\} [Q_t K_{t+1} - N_{t+1}^F]$$

### 6.1 Dynamics of the model with dynamic provisioning

Figure 6 illustrates the impact of dynamic provisioning on the procyclicality of bank provisions. To do so, a cycle is artificially simulated with two symmetric and unexpected monetary policy shocks ( $\varepsilon_t^i = 0.5$  et  $\varepsilon_{t+3}^i = -0.5$ ). The box on the left clearly shows the negative correlation between output and provisions when the latter are recorded in accordance with a static

<sup>14</sup> For a detailed presentation of this concept on practice, see Jaudoin (2001). For the moment, this principle has only been widely applied in Spain and Portugal.

<sup>15</sup> In this respect, Fernandez de Lis & Al. (2000, p.15) emphasise the following: "if bank stockholders perceive the lower profit volatility as a measure of lower risk, they could fund the bank at cheaper rates". See also Caruana (2003).

<sup>16</sup> In practice, the regulatory framework for dynamic provisioning provides that expected losses be defined as the average losses expected for the next 12 months. Bearing this in mind, in the model, losses are based on the rational expectations of the wholesalers' bankruptcy rates. Indeed, the agents know the model and can deduce from it an evaluation of the economic activity (which is a determinant of the firms' bankruptcy rate), one period ahead.



In the dynamic provisioning system, since banks have recorded provisions beforehand in proportion to loans already granted, the negative shock has a lesser effect on their net wealth. As a result, their external finance premiums increase to a lesser extent than in the static provisioning system. Finally, the rise in firms' premiums is also smaller. Hence the lessons to be drawn from the model are as expected: the economy is less sensitive to shocks under a dynamic provisioning system.

6.2 The contribution of dynamic provisioning:  
an assessment

We shall assess the contribution of the dynamic provisioning system in terms of output, inflation and interest rate volatility. To do so, the variances of these three variables are calculated over 25 periods after two successive shocks<sup>17</sup> (technology and bubble) in two financial contexts: baseline context with  $\overline{WB}/\overline{B} = 0.1538$  and weak financial context with  $\overline{WB}/\overline{B} = 0.075$ . It is then possible to compare the variances depending on whether the banks employ a static or dynamic provisioning system. The results are given in Table 1.

		Technology shock		Bubble	
	Context:	Baseline	Weakness	Baseline	Weakness
Static provisioning	$Var(y)$	0.556	0.696	0.806	1.114
	$Var(\pi)$	0.041	0.258	0.164	1.029
	$Var(i)$	0.098	0.624	0.326	2.504
Dynamic provisioning	$Var(y)$	0.542	0.591	0.789	0.793
	$Var(\pi)$	0.036	0.152	0.149	0.634
	$Var(i)$	0.084	0.372	0.281	1.599
Contribution of dynamic provisioning (in %) <sup>(a)</sup>	$Var(y)$	-2.52	-15.08	-2.11	-28.81
	$Var(\pi)$	-12.19	-41.08	-9.14	-38.38
	$Var(i)$	-14.28	-40.38	-13.80	-36.14

Table 1: Comparison between static and dynamic provisioning

<sup>(a)</sup> : Comparison of variances between the two types of provisioning, in %

<sup>17</sup> The calculation of theoretical moments is impossible because of the non-linearity arising from the definition of the asset-price bubble.

rates the significance of the financial context. Typically, for a given shock, the amplitude variation of external finance premiums is greater in a weak financial context. In addition, the examination shows that premiums are more sensitive to the banks' financial structure than to that of firms. As a result, the reactivity of output and inflation is all the greater when banks and firms are initially low-capitalised. Thus, a stock market crash occurring in a globally weak context would involve fluctuations (or even a depression) out of all proportion to what would happen in a globally healthy context. Consequently, in accordance with theoretical and empirical contributions concerning the banks' capital channel, a normative interpretation of this result leads to emphasising the importance of prudential policy. Indeed, although monetary policy is doubtless necessary to curb a credit surge caused by an asset-price bubble, it is not an adequate instrument to control the overall financial context, as it is shown by capital crunch events.

Provided they are used pre-emptively, prudential measures should, therefore, constitute a complementary instrument of regulation. In this respect, the model inserts banks' allocations for provisions which weigh on bank capital in crisis periods and strengthen its procyclicality. This feature allows for a study of prudential policy, represented here by a dynamic provisioning mechanism. Simulations indicate that the setting up of this system allows a considerable decline in the volatility of the main macroeconomic variables to be brought about. The expected advantages are hence affirmed on theoretical grounds. On practical grounds, such an implementation is all the more interesting in that it is consistent with the spirit of Basel II. Indeed, the methods and data used by banks for the internal assessment of their capital requirements can be transposed to the calculation of expected losses.

Several extensions should be pursued. First of all, if the main macroeconomic aggregates and ratio at the steady state show appropriate values with respect to the characteristics observable in the euro area, it would be appropriate to make a more accurate estimation of the premium elasticities to the banks' and firms' balance sheet structures. Furthermore, the simulations indicate that prudential and pre-emptive measures are conducive to smoothing output. This perspective is encouraging for economies whose fiscal policy is locked up and where stabilising inflation is the one and only objective of the central bank. Hence it is worth carrying out a finer study of the complementarities and the way in which monetary policy and countercyclical regulation can be coordinated. All the more so in that gains from dynamic provisioning are particularly obvious in a context of financial weakness. And it is precisely in this context that monetary policy is the least efficient.

Finally, many contributions and opinions have concerned the need for central banks to target asset prices. The bank-capital channel renews this question, extending it to the boundaries between monetary and prudential policies. If a counter-cyclical prudential policy is efficient for preventing the



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$$\frac{\bar{N}^B}{\bar{B}} = [\gamma_B (1 - \tau) + \tau] \bar{R}^B \frac{\bar{W}\bar{B}}{\bar{B}} \tag{45}$$

$$\frac{\bar{N}^F}{\bar{K}} = \frac{(1 - \alpha) (1 - \Omega) \frac{\bar{Y}}{\bar{K}} \bar{\rho}}{1 - \bar{\gamma}_F \bar{R}^F} \tag{46}$$

where  $\frac{\bar{N}^F}{\bar{K}}$ ,  $\frac{\bar{G}}{\bar{Y}}$  and  $\frac{\bar{W}\bar{B}}{\bar{B}}$  are exogenous, and  $R^B = \frac{1}{\beta}$ .

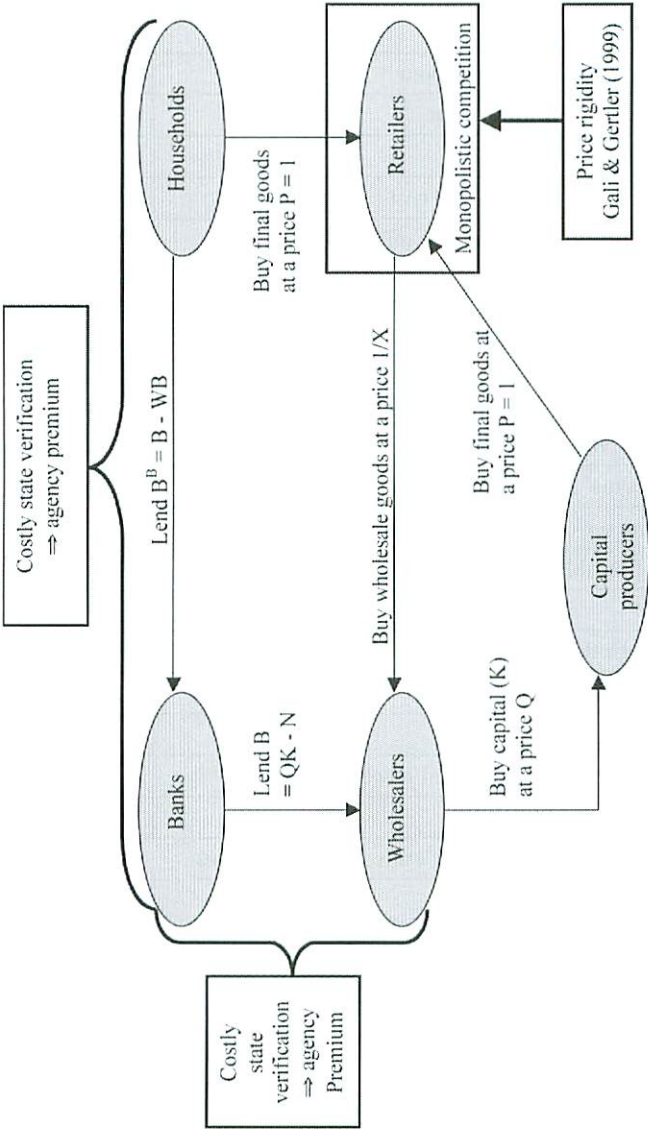


Figure 8: Main connections in the model